A comprehensive Water Infrastructure Asset Management and Optimisation Project for North Sydney Council's Largest SWH Scheme

By: **Omid Sayar** – Optimal Stormwater

BE chemical & process engineering

Masters in Environmental Engineering (Water & Wastewater Treatment) at UNSW
Masters in Engineering Management (Waste & Pollution Management) at UTS

By: **David Manson** – North Sydney Council

Manager Parks & Reserves

By: **Mahdi Madani** – Optimal Stormwater

BE Process Engineering

Masters in Process Engineering

ABSTRACT

In 2016 North Sydney Council engaged Optimal Stormwater to review and upgrade a $1.2M stormwater harvesting scheme built in 2006, which was previously providing limited benefit for the investment. The objective was to assess/audit the stormwater harvesting scheme and determine what was required to bring the asset back to life, and meet Council's expectations in terms of reliability, quality and quantity of water produced.

The upgrade and optimisation project ran over 2 years and began with a complete audit of the system's processes, then a plan to clean and/or rectify unacceptable components, then development of an ongoing Operation & Maintenance program, and finally execution of an Asset Optimisation Plan.

Two years later, North Sydney Council now have a $1.2M stormwater harvesting scheme which is producing 5 times as much recycled water, meeting the National Guidelines for water quality and all at a lower energy and lower ongoing O&M costs.

This paper outlines the process and key upgrades to achieve this excellent outcome for the Council, community in North Sydney and the environment.

Overview of the Project

North Sydney Council constructed their first and largest stormwater harvesting scheme in 2006. They invested approximately $1.2M in the GPT, pipelines, treatment and storage. The scheme involved tapping into a continuous low flow, treating the stormwater through a CDS Unit before it being was sent by two separate pumps to two separate reuse applications.

One of the pumps transferred stormwater with a flow rate of 18 L/s to a dam constructed at Cammeray Golf Course for storage and pre-treatment, and from there water was pumped to a treatment room then delivered as the primary source of irrigation for the Golf Course as well as Primrose Park, Tunks Park and Forsyth park.

The other pump transferred water with a flow rate of 4L/s to be treated in the North Sydney Council Depot and stored in a 100,000 kL underground storage tank. It was used as the primary source of irrigation water for North Sydney Oval, St Leonard's Park and Bon Andrews Oval. It should be noted that all the irrigation sites were also equipped with a back-up potable supply, that was previously being used a lot more often than it should.

Although the treatment rooms housed high quality filters, high performance UV disinfection and chlorine dosing systems, the scheme was plagued with operational issues, and was not meeting Council's expectations in regards to reliability, quantity of water or quality of water.

In 2016, Council decided to get serious and engaged Optimal Stormwater to give the whole scheme a very thorough assessment. There were issues with low flow bypassing, the GPT had been damaged and was not being cleaned correctly, the pumps had not been serviced and were trying to pump sludge, the screen filter had been disconnected, the chlorine dosing was never commissioned and the UV system had failed. The pumps weren't delivering the volume of water they were supposed to, the storages were contaminated and the treatment was not producing water quality that would meet appropriate stormwater reuse guidelines. For such a significant investment, it was a very disappointing situation that needed to be addressed.

Because Optimal Stormwater had experience in design, construction, auditing and O&M, they were a logical choice to partner Council to do the upgrade, and Council were very pleased with the project outcomes and successes.

Over the past 2 years the project involved a comprehensive Audit of the SWH scheme and systematic review of every component involved in it. Water quality analysis was done, pump checks, flow checks, plus an audit then rectification works on the CDS unit. The filters got an upgrade, UV system replacement in the depot, design and installation of an 18L/s high pressure UV for the golf course, design and installation of a new aerator for the dam, disinfection of the main tank, and commissioning of the chlorination system. But the upgrades didn't stop there, there were upgrades to all project electrics, upgrades to the control system, and then everything was commissioned.

Council now has a scheme that (1) works, (2) is delivering 5 times the volume of water, (3) meets the National Guidelines for water quality for the first time, and (4) is doing this at a lower energy cost and lower ongoing O&M expense. The scheme is now everything Council expected it would be, and everything they need.

The Scheme

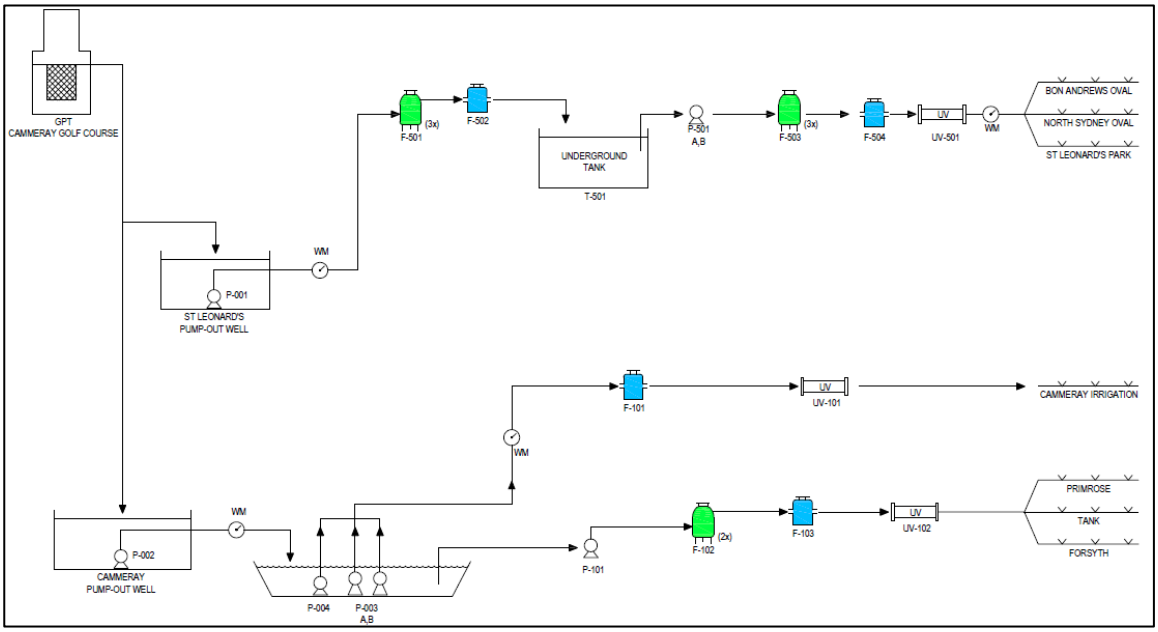

Figure 1 Process Flow Diagram of the North Sydney SWH Scheme

Council had the base asset, but its "management" was not up to scratch. They now have a comprehensively upgraded asset that is as good, or better, than any other scheme in the industry. Council are proud and excited of what their "new asset" is now delivering. North Sydney Council can now harvest more than 100 million litres of stormwater needed to irrigate all their parks, and the Cammeray Golf Course.

Location of the Project

The catchment feeding into the stormwater harvesting scheme includes part of the Warringah Freeway, as well as 94ha of mostly high density residential land. The water produced by this scheme feeds a Golf Course and 6 of Council's major ovals around North Sydney. The scheme provides a fantastic example of centralised treatment and decentralised use.

The location of the offtake is below Cammeray Golf Course, and the main treatment facilities are located at Cammeray Golf Course and the North Sydney Council Depot.

Figure 2 Aerial View of the Sites Irrigated through the Scheme

Steps Involved in the Project

The following list includes the works undertaken by Optimal Stormwater throughout the course of the project:

Step 1: **Comprehensive Audit of the Scheme**

1.1. Process and existing documents review
1.2. Database preparation (vital source for any rectification planning and future operations)
1.3. Centralised monitoring assessment (review the production and equipment trends, flowrates, run hours, alarm history)
1.4. Review and assessment of the service reports
1.5. Interviews with the operators and end-users to develop the database
1.6. Equipment and controllers condition assessment (electrically, mechanically and process capacity)
1.7. Pre-treatment and intake comprehensive assessment (including review of cleaning frequency, check the GPT screen and functionality, check the pump well at low and high level, check the intake pumping system)
1.8. Tanks condition (water quality, level controllers and switches, top-up philosophy, sediments and sludge level, internal structure, overflows)
1.9. Music modelling
1.10. Monitoring of the stormwater flowrates in the channel to assess the maximum harvesting scenario (installed a temporary ultrasonic flowmeter)
1.11. Energy efficiency assessment on the equipment to optimise the electrical consumption
1.12. Equipment and asset list preparation
1.13. Preparation and development of detailed P&IDs
1.14. Preparation of a detailed functional description
1.15. Comprehensive Water Quality Analysis (wet and dry condition)

1.16. Detailed report preparation for different stakeholders involved in the project (sustainability team, operation team, asset management team)

Step 2: Planning and Preparation

2.1. Rectification List and Steps – Scoring Method; considering Cost, Benefit (Environmental/Operation/Health), Criticality, Timeframe and Risk (CBA Method). For each of the elements, a 3x3 factors analysis was completed, which included E/O/H factors, Capital, Timeframe and Ongoing Operation Cost involved with each recommendation.
2.2. Brainstorming workshop to discuss the Rectification List.
2.3. Action List and delivery timeframe (based on the feedbacks from the Brain Storming Workshop)
2.4. Development of Operation and Maintenance Program
2.5. Development of a Comprehensive Water Quality Monitoring Plan

Step 3: Execution of the Asset Optimisation Plan

3.1. Recommissioning of two large Chlorination systems (including CT requirements)
3.2. Design and installation of three SMART UV systems (run the lamps based on the UVI at a designated set point)
3.3. Fix the pre-treatment system, give it a very comprehensive clean for the first time, and comprehensive cleaning of the intake pump well
3.4. Design and installation of an aeration system with timing program to improve the water quality in the storage Dam
3.5. Improvements on the centralised control and monitoring system
3.6. Adjustments on potable water supply system
3.7. Rectifications on the irrigation pumping system
3.8. Replace and upgrade the intake pumps as the old pumps were not delivering the maximum designed flowrates (harvesting and energy saving)
3.9. Storage tank disinfection
3.10. Filtration system rectifications
3.11. Implementation of the optimised operation and maintenance program (resulted in more comprehensive program and this reduced the annual operation cost by $27,000)
3.12. Execution of the Water Quality Monitoring Program (dry and wet weather)
3.13. Development of the asset list including:

- Condition
- Model
- Tag number
- Size
- Type
- Procurement or Installation Date
- Manufacturer date
- Last service
- Importance
- Functionality
- Location condition
- Cost

Stormwater Issues Addressed by the Project

The CDS unit had a poor cleaning history. As such, Optimal Stormwater investigated the whole solution and identified issues including no cap on the bypass, no volute cleaning, pumps covered in sediment and screens damaged by machine impact. After having the screen fixed, we changed cleaning contractors, did the clean right, and increased the cleaning frequency. As a result, the pollution capture is significantly higher, and it's now providing excellent pre-treatment.

The Water Quality resulting has massively improved for both the environment and water reuse systems. We've also serviced the filters and put in smart UV systems that use less energy, plus chlorination, and our water quality is now meeting the requirements for protozoa, bacteria and viruses. We irrigate sporting facilities and public parks, so it is now reassuring to be producing excellent quality water, with Council meeting all its "Due Diligence" expectations, with the validation to prove it.

Stormwater Reuse is the heart and soul of this project. As such, comparing 300 kL per annum of recycled water production to the current production of 100ML per annum or even more, based on the demand, reveals the significance of the rectification and optimisation carried out so far. Council even has plans to expand the scheme to another park in not too distant future.

In regards to ecosystem health, we are removing an estimated 80 tonnes per annum of gross pollutants, plus the associated TSS and nutrients. The new aerator in the dam has seen the algal problems go away, and it's now fit for a thriving ecosystem once again. In addition we managed to reduce E.coli levels which ranged between 1000-2000 CFU/100mL in the GPT to less than 1 CFU/100mL which perfectly meets the guidelines (< 10 CFU/100mL). This was achieved through media filtration and installing a new UV disinfection system which was designed to see the worst-case-scenario in terms of UVT. As shown in **Figure 3** approximately 20 samples have been collected so far, from March 2017, to regularly monitor treated water with regards to E.coli. The results show the system has been continuously delivering fit-for-purpose and hygienic irrigation water to all sites.

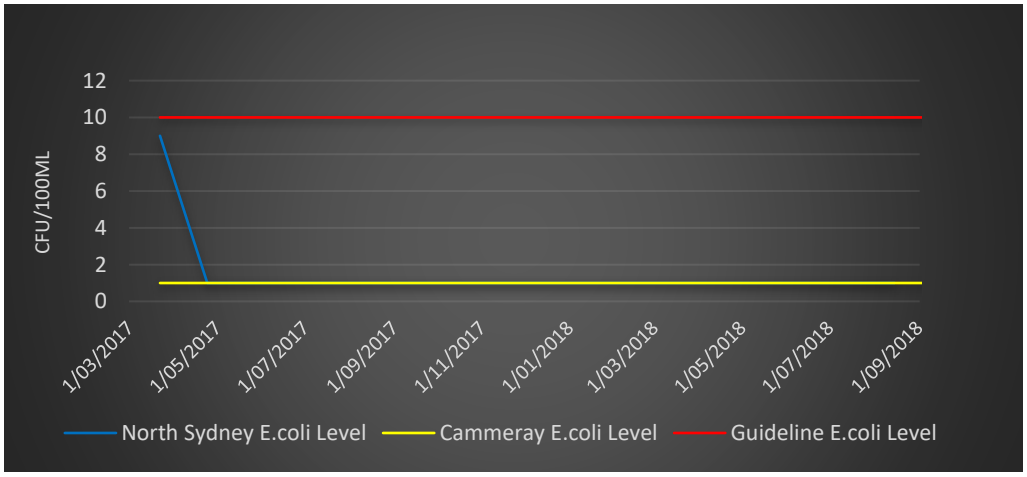

Figure 3 E.coli Levels in Recycled Water Produced at the Two Major Treatment Points in the Scheme

Prior to auditing and optimisation, the scheme had a simple low flow bypass cap missing, that saw hundreds of thousands of litres of untreated water bypass it. Now it's fixed, it treats over 95% of all water and harvests as much as the parks need.

Prior to this project, the Cammeray treatment room had no disinfection and the North Sydney treatment had an old system which was unreliable at best. As public health and safety has always been one of the major drivers for the entire project, we improved our treatment facilities by implementing an 18L/s high flow/high pressure UV for the Golf Course and a 4L/s new smart UV system for the parks (Forsyth, Tunks, and Primrose). The old UV was so temperamental it kept shutting the system down. Now we have state-of-the-art disinfection for all our water, and it's been validated to be working perfectly. Now the park users and the golfers can be happy, and safe too.

Figure 4 Two new UV Disinfection Units Installed in Cammeray Treatment Shed

Issues with the system were classified into three categories:

1) **Health**
   a) Bacteria Log Reductions Requirements
   b) Microbiological Water Quality Monitoring
   c) Disinfection Systems Requirements (design)
   d) Emergency Response Plans
   e) Storage Tanks Water Quality and Condition Reporting
   f) Safety Showers and MSDS

2) **Operational** (affecting operational cost and stormwater harvesting volume)
   a) Water quality monitoring that could affect equipment performance
   b) GPT Functionality
   c) Equipment performance and condition
   d) Asset List Preparation
   e) Operation and Maintenance
   f) Centralised monitoring system bugs and potential improvements
   g) Monitoring and Control equipment
   h) Potable water supply mechanism

3) Environment

a) GPT performance to maximise the pollution removal from the stormwater culvert
b) Algae Bloom potential in the storage dam
c) Chemical Spills

The following issues are some examples that were raised during the audit process:

- Low log reductions for the process. Log reductions for the system were not meeting the Australian Guideline for Stormwater Harvesting but after the rectifications we are well above the guideline limits. Below is the log reduction surplus value compared to the guidelines for the current system (after rectifications)

Bacteria	Protozoa	Viruses
✓ +2.7	✓ +2.2	✓ +0.7

- Lack of a systematic database to keep records of the system (WQ, Operation, servicing, Breakdown History, Rectifications)
- Not having satisfactory design documentation and operation plans
- Under performing equipment such as intake pumps, Filtration, Storage Dams, high energy consumption (a pump with a broken impeller needs to work more to push even lower amounts of water compared to a healthy and optimum-sized pump with a Variable Speed Drive)
- Issues with the GPT Screen. Issues with a lack of cleaning in the volute and around the pump intakes, and the upstream pipe and diversion chamber.
- Non-operational equipment such as the UV "stream clean" system for St Leonard's, and the Chlorination systems at Cammeray and the Depot
- Lack of sufficient Emergency Response Plans to attend to any breakdowns
- Algae blooms in the storage dam before installation of an aerator with a timing program
- High operation cost due to lack of comprehensive operation and maintenance plan
- Under performing water quality monitoring program.

Project Costs and Outcomes

The GPT is costing more to clean, because now it's working at 100% instead of under 50% previously, but now it's doing the job it was designed to do and gets cleaned monthly, with removal of around 10m^3 per month!

The harvesting scheme has gone from "unreliable & problematic" to "excellent and cost effective" for under $200,000 in upgrade capital costs. So for less than 20% of the initial capital cost, the scheme has been reviewed, renewed, upgraded, and optimised.

Council sought quotes from potential companies to operate this upgraded system, and Optimal Stormwater were successful in winning the ongoing O&M. But with everything fixed and by engaging a partner that specialises in stormwater harvesting, an ongoing cost saving of 40% was achieved by Council. So now it's producing more than 5 times more water, for only 60% of what it was costing previously. This is an excellent result for Council.

The water now being of a quality that is fit for irrigation and reliably meeting the guidelines also eliminates any Council liability, reduced risk for all stakeholders, and a significant reduction in administrative costs for operation.

The system is producing more than 100 million litres per year, with operating costs of approximately $27,000 pa. In simple terms that's 27cents/kL, which is about 15% of the price of potable water, AND a LOT more sustainable.

Summary

North Sydney Council started this project 2 years ago when the stormwater harvesting scheme they had was not meeting their expectations, due to problems with just about every part of it. The water supply & demand, and the initial investment had seen a good harvesting scheme constructed, but poor maintenance in the 10 years after its installation saw it become more of a liability than an asset.

Optimal Stormwater were engaged as experts in this field to partner with Council and try to get the asset back to its full potential. It needed a substantial upgrade to many neglected components, some significant cleaning and maintenance, some new equipment to ensure it could meet relevant industry guidelines, and then there were many areas for optimisation of the scheme.

This *Water Infrastructure Asset Management Review, Upgrade and Optimisation* has been a complete success, reliably producing 5 times the water, for only 60% of the cost. All parks and the Golf Course now have more water than they need, which is being produced at about 15% of the cost of the equivalent potable water. The water is reliably meeting all the requirements for irrigation in public areas, and the scheme can now be considered for expansion. It has also massively improved WHS, and all but eliminated Council's risk in this regard.

This project demonstrates that, one of the most critical elements in achieving water sustainability targets is the ongoing Operation and Maintenance of the scheme. An audit or review of the scheme by an independent expert company in this field could very likely pay dividends, as it has for North Sydney Council. This type of review is recommended for all stormwater harvesting schemes, once a decade, and hopefully other Councils can achieve the same array of positive outcomes that North Sydney Council has.